Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Reallocation of Television Channels 60-69, the 746-806 MHz Band	)	ET Docket No. 97-157
	)	

To: The Commission

COMMENTS OF FINAL ANALYSIS INC.

Final Analysis Inc. ("Final Analysis"), pursuant to Sections 1.415 and 1.419 of the Commission's rules, 47 C.F.R. §§ 1.415, 1.419, hereby submits its comments on the above-captioned *Notice*.[1] The *Notice* proposes reallocation of certain spectrum in the 746-806 MHz band, currently comprising television channels 60-69, for fixed and mobile services, including public safety use. For the reasons discussed below, Final Analysis urges the Commission to reallocate a portion of the 746-806 MHz band for use by non-voice non-geostationary mobile satellite service ("NVNG MSS" or "Little LEO") operators.

Final Analysis, through its subsidiary Final Analysis Communication Services, Inc. ("FACS"), is building and preparing to launch and operate a worldwide, digital Little LEO satellite telecommunications system that will offer low-cost, high-quality two-way data transmission services such as paging, e-mail, data acquisition, fixed and mobile asset tracking and position location determination. The record in the *Little LEO* proceeding demonstrates

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[1] *See Reallocation of TV Channels 60-69, the 746-806 MHz Band*, Notice of Proposed Rulemaking, ET Docket No. 97-157, FCC 97-245 (released on July 10, 1997) ("*Notice*"). Comments are due in this proceeding on September 15, 1997, and reply comments are due on October 14, 1997. *See* 62 Fed.Reg. 41012 (July 31, 1997).

that Little LEOs will require an additional 21 MHz of spectrum[2] on a shared, worldwide basis to deploy commercial systems that will sufficiently meet the demand for near-real time Little LEO applications.[3] Accordingly, to the extent that the proposal in this proceeding to reallocate spectrum in the 746-806 MHz band from broadcast use to fixed and mobile service applications could help to meet the spectrum requirements of Little LEO operators, Final Analysis has a significant interest in this proceeding

The record in the *Little LEO* proceeding demonstrates that there is a large demand for near-real time Little LEO applications such as automated meter reading, asset tracking, vehicle messaging, personal messaging and remote monitoring and supervisory control and data acquisition ("SCADA").[4] Final Analysis believes that reallocation of a portion of the 746-806 MHz band to Little LEO use is in the public interest because it would make necessary spectrum available to Little LEO operators to develop commercial systems to meet the global demand for these services. Furthermore, reallocating additional spectrum to Little LEOs from the 746-806 MHz band is consistent with Resolution 214 of WRC-95

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[2] This 21 MHz of additional spectrum excludes the existing allocation of approximately 3.5 MHz of spectrum already allocated to Little LEOs on a worldwide primary shared basis at the World Administrative Radio Conference in Torremolinos, Spain in 1992 ("WARC-92").

[3] *See Amendment of Part 25 of the Commission's Rules to Establish Rules and Policies Pertaining to the Second Processing Round of the Non-Voice, Non-Geostationary Mobile Satellite Service*, Notice of Proposed Rulemaking, IB Docket No. 96-220, FCC 96-426 (released October 29, 1996) ("*Little LEO Notice*"); *see also* Comments of Final Analysis Communication Services, Inc., filed in IB Docket No. 96-220 on December 20, 1996.

[4] *See* International Telecommunications Union, Radiocommunication Study Group, Sub Working Group 8D3A-6, *Spectrum Demand for Non-GSO MSS Below 1 GHz Services*, Document 8D/TEMP/128-E, dated November 5, 1997 ("Demand Study"), attached hereto as Attachment A.

which recognizes the need for allocation of additional spectrum to mobile satellite service ("MSS") operations, including Little LEO operations. below 1 GHz to meet projected demand for such services.[5]

Moreover, in case Little LEOs are required to share with broadcasters in the 746-806 MHz band after reallocation, sufficient frequency coordination techniques may be implemented to allow shared use of that spectrum with broadcasters on a non-interference basis. In particular, international studies conducted pursuant to Resolution 214 of WRC-95 show that shared frequency operations between Little LEO operators and broadcasters is technically feasible but would require further analysis to establish the detailed sharing criteria.[6]

Accordingly, for the foregoing reasons, Final Analysis urges the Commission to reallocate 21 MHz of spectrum in the 746-806 MHz band to Little LEOs. Such

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5 *See id.*

6 *See* Draft Text for CPM Report, Sub-Working Group 8D-3A, *MSS (Space-to-Earth) Sharing with the Broadcasting Service*, Document 8D/TEMP/115(Rev.1)-E (dated November 5, 1996), attached hereto as Attachment B.

reallocation is in the public interest as it will facilitate the deployment of commercial Little LEO systems to meet global demand for commercial Little LEO services.

Respectfully submitted,

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Dated: September 15, 1997

ATTACHMENT A

LITTLE LEO SPECTRUM DEMAND STUDY

INTERNATIONAL TELECOMMUNICATION UNION

RADIOCOMMUNICATION
STUDY GROUPS

Document 8D/TEMP/128-E
5 November 1996
Original: English

Source: Document 8D/136

Sub-Working Group 8D3A-6

INFORMATION DOCUMENT IN SUPPORT OF CPM TEXT TO BE ATTACHED TO THE REPORT OF THE CHAIRMAN OF WP-8D

SPECTRUM DEMAND FOR NON-GSO MSS BELOW 1 GHz SERVICES

1 Introduction

In its considerings, Resolution 214 of WRC-95 "indicated that, in order to meet projected MSS requirements below 1 GHz, a range of an additional 7 to 10 MHz will be required in the near future." This information document summarizes the results of a study conducted to make more certain and more definitive future spectrum requirements for the MSS below 1 GHz.[1]

While any market assessment at such an early stage of development is uncertain, the demand scenarios constructed based on the study results suggest strong potential demand for NGSO MSS services. How much of this business potential is achieved will depend, among other factors, on the availability of sufficient spectrum worldwide to enable the development of these systems.

In addition to the study's market demand findings, this paper calculates the bandwidth for service links and feeder links that would be required to carry this traffic.

1.1 Scope

While there is broader potential for NGSO MSS satellite services, the scope of the study was concentrated on the following five application areas:

- Automated Meter Reading (AMR) for utilities industries
- Asset Tracking for the transportation and freight industries
- Vehicle Messaging for commercial vehicles and the trucking industry
- Personal Messaging for mobile individuals
- Remote Monitoring and Supervisory Control and Data Acquisition (SCADA) for oil and gas pipeline operators and individuals.

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[1] *Business Opportunities in the Little LEO Satellite Services Market*; A Report Prepared for Final Analysis Communication Services Inc. by Deloitte & Touche, a major international consulting firm.

Analysis of the growth rates and drivers in the selected application areas was based on the seven-year time frame 1996-2002.

1.2 Methodology

Due to the early stage of development of NGSO MSS technology, the study relied heavily on in-person and telephone interviews to create the fact base. In all, more than 30 face-to-face interviews and more than 50 telephone interviews were conducted with three categories of people:

- End users in the target application areas
- Functional competitors and/or industry resellers (Big LEO service providers, terrestrial wireless communications providers)
- Industry observers (industry analysts in the financial community, industry consultants, journalists (trade) and equipment suppliers).

These created an up-to-date fact base, permitting less reliance on market reports or company brochures that might be outdated and/or set overly optimistic expectations for market demand or for end-use costs in adopting NGSO MSS satellite technology.

The interviews were supplemented by an extensive data-gathering effort based on secondary research sources - company documents, market research reports, and searches of trade journals.

In international markets for which data are not available, estimates were made based on benchmarks derived from known markets with similar economic, regulatory, and competitive environments.

1.3 Analysis

The overall market size was estimated based on the installed base of terminals in each application area. The growth rate applied was based on either historical growth trends or published growth projections. The addressable market size was based on an assessment of the NGSO MSS value proposition and its fit with end user technology selection criteria. To avoid "double-counting," the addressable market is an estimate of the number of users that could best be served via NGSO MSS technology. In each application area, alternative competitive technologies have been taken into account.

For each potential application area, the addressable market for NGSO MSS services is that portion of the total available market where NGSO MSS features and capabilities are likely to be more attractive than that of the substitute technologies, as perceived by end users and providers of substitute technologies.

The work performed by the study involved development of forward-looking demand scenarios based on interviews with industry participants and secondary data sources.

2 Addressable markets

The following information sets were developed for each market:

- Total market in units by year and region
- NGSO MSS addressable markets
- End-user technology selection criteria

- Assessment of functional substitutes
- NGSO MSS share of market
- Size of the NGSO MSS addressable market by year and by region.

For each market, the study assessed the ability of a variety of incumbent terrestrial and satellite-based wireless technologies to meet customer needs.

AUTOMATED METER READING

The number of utility meters was determined by taking the total installed base of conventional utility meters. In international markets for which data was not available, the study estimated the total number of meters based on benchmarks for the number of meters per capita for known markets with similar economic, regulatory and competitive environments. Next, seven-year projections were developed based on historical growth rates for the size of the installed base.

ASSET TRACKING

Estimates of the total number of commercial vehicles, cargo trailers and shipping containers were developed by determining the total installed base of commercial vehicles, cargo trailers and shipping containers in the world.

VEHICLE MESSAGING

Estimates for the total number of truck tractors, commercial vehicle and ships which could be equipped with messaging terminals were developed first by determining the total installed base of tractor trailers, commercial vehicles and ships in the world. In international markets for which data was unavailable, the total number of such vehicles was estimated based on benchmarks for the number of vehicles per capita for known markets with similar economic, regulatory and competitive environments. Growth projections were developed based on historical growth rates or, where available, industry projections for specific types of vehicles and ships.

PERSONAL MESSAGING

Estimates of the total number of personal messaging devices in North America and international markets are based on numerous industry data sources, including Mtel Corporation (Skytel), RAM Mobile Data, and Motorola.

SCADA

For SCADA, the study focused only on oil and gas providers. Determination of the total number of compressor-station SCADA remote terminal units was based on known data for a large number of oil and gas providers in North America, as well as an estimate for compressor-station remote terminal units based on North American benchmarks for the average number of remote terminal units per mile of pipeline. Industry sources relied on for data include the Oil and Gas Journal, as well as data published by the Petroleum Institute giving an overview of existing pipelines worldwide and projections for new pipeline construction and retirements over the next decade.

SUMMARY

The market study identified 42.9 million potential users for NGSO MSS services in the five application areas studied. Table 2-6 provides a summary of this projected market by area of application and regional use.

TABLE 2-6

Projected world market for NGSO MSS technology major application areas for the period 1996-2002

	North America	Europe	Latin America	Asia	Africa	Global Total
Automated Meter Reading	14,874	4,830	1,888	8,703	239	30,534
Remote Asset Tracking	844	296	77	N/A	N/A	>1,347
Vehicle Messaging	1,403	645	172	166	17	2,405
Personal Messaging	1,630	2,569	966	3,368	103	8,636
SCADA	12	8	2	6	1	29
Regional Total	18,763	8,348	3,105	>12,243	>360	>42,951

All numbers are in thousands.

N/A = not available.

2.2 Assessment of competitive technologies

To determine the addressable market for NGSO MSS services, functional requirements were identified for each application area, and then a variety of competitive, alternative terrestrial and satellite-based wireless technologies were identified and assessed as to their ability to meet the identified user needs.. The alternatives substitutes included in the study, and the requirements identified for each application are as follows:

Automated Meter Reading

Requirements:	Low Cost per Read; Current Value-added Functionality; Compatibility with Existing Systems, Minimal Technology Risk; Prospect for Future Value-Added Capabilities; Rapid Installation and Deployment
Competitive Technologies:	Manual (visual) reads, hand-held radio, mobile radio, fixed cellular networks

Asset Tracking

Requirements:	Geographic Coverage and Flexibility; System Reliability; Low Operating Costs; Low System Costs; Rapid Updating
Competitive Technologies:	GEO, cellular networks, specialized mobile radio data networks, Big LEO

Vehicle Messaging

Requirements:	Footprint of Coverage Area; Application Features and Functions; Near Real-time Connectivity; High Data-rate; Low Messaging and Terminal Costs; Small Terminal Size
Competitive Technologies:	GEO, cellular networks, specialized mobile radio data networks, Big LEO

Personal Messaging

Requirements:	Footprint of Coverage Area; Application Features and Functions; Near Real-time Connectivity; High Data Rate Capability; Low Messaging and Terminal Costs; Small Terminal Size
Competitive Technologies:	Specialized mobile radio data networks, cellular networks, GEO, Big LEO

SCADA

Requirements:	High Reliability and Redundancy; Real-time; Secure Communications; Capacity to Handle Peak Traffic; Ease of Integration; Speed to Deploy
Competitive Technologies:	Microwave, leased telephone circuits, GEO, fixed cellular networks

The market research studies, which resulted in the numbers of prospective users shown here for the five application areas for NGSO MSS services, took into account the cost and features the competing, alternative technologies listed above. Thus, the projected market shown in Tables 2-1 through 2-6 is the net market for NGSO MSS services. That is, these tables represent the overall number of prospective users for these services, after subtracting for those that would use competitive, alternative technologies.

3 Required bandwidth for NGSO MSS

For technical and economic reasons, this study is focused on frequency bands below 1 GHz for NGSO MSS service links. Using nearly omnidirectional gain patterns for the Mobile Earth Station (MES) antennas, the lower free-space propagation losses at VHF and UHF result in positive link margins using moderate transmitter powers (on the order of 5 - 10 W). These factors minimize the cost of MES and make them economically viable. However, the higher free-space losses at frequencies slightly above 1 GHz can be overcome for feeder links by using higher transmitter power and higher gain, narrow-beam tracking antennas at feeder link stations.

Some of the application areas summarized in Table 2-6 are primarily one-way. For example the bulk of the traffic on the service links for Automated Meter reading and remote tracking, will be from mobile earth stations to a satellite (i.e. service uplinks). In other application areas (e.g. Messaging) there will be more or less equal traffic on the service links in both directions between the satellite and mobile earth stations (i.e. on service uplinks and service downlinks). Similarly, traffic on feeder links will differ in the two directions of transmission. Therefore, spectrum requirements will be calculated separately for the four links between satellites and earth stations.

The first step in converting traffic demand into spectrum is to calculate the bandwidth that would be required in each of the four directions of transmission if that spectrum were to be used only by NGSO MSS systems. (This unlikely assumption is made only as a first step in calculation of the spectrum that would be required on a shared basis. All current MSS NGSO allocations are in bands shared with other services.)

Since all MSS NGSO spectrum will undoubtedly be shared with other services, the overall allocation to the several services in shared bands must obviously be larger than the spectrum required by any one of them. Thus, the spectrum required for MSS NGSO systems on an exclusive basis must be increased by a factor that will take into account the traffic requirements of other services; the requirement that NGSO MSS systems use only those channels within a shared band that will not cause interference to, or receive interference from, those other services; and the difficulty created by the wide range of domestic assignments made in shared bands by different countries around the world.

As discussed below, this study uses a multiplication factor of 5.0 to account for shared frequency usage, based on current terrestrial cellular experience.

However, even this multiplication factor of 5 does not take into account another aspect of the shared use of spectrum by systems providing global service that would increase the amount of spectrum that must be allocated to a service, above that dictated by the two shared-use factors discussed above. That is the wide difference in domestic allocations and assignments made by different countries around the world. For example, if 1 MHz were required for NVNG MSS, and a certain 5-MHz band were to be designated to be shared by it and other services on a worldwide basis, that particular 5-MHz band might be much more heavily used in some countries than others, or might be used in some countries by services that would make sharing difficult. That would result in NVNG MSS systems not being able to find enough non-interfering, and non-interfered-with channels in those countries. The solution would be to designate a wider band for sharing than the 5 MHz in the example above. The resulting use made by NVNG MSS systems in the larger band would still be only 1 MHz, but it would be a different 1 MHz in different countries.

3.1 Required bandwidth for NGSO MSS service uplinks

To estimate the total required uplink bandwidth, the following assumptions are made:

- The allocated frequency band will be used on a shared basis.
- The modulation type is GMSK, which results in a channel bandwidth 1.5 times the baud rate.[2]
- The average packet size is 128 bytes, or 1 024 bits, including overhead.
- Data transmission is uniformly distributed over the total available transmission time. (Several factors justify this conservative assumption. For one, typical NGSO satellites have footprints with a diameter of about 5 000 km, which encompasses three time zones. Therefore, traffic peaks during the Busy Hour will be spread out. Secondly, a major

[2] The multiplier of 1.5 for GMSK modulation is assumed only for the purpose of calculating required bandwidth for initial NVNG MSS systems, and is not meant to imply that modulation methods having greater efficiencies of bandwidth utilization will not be employed or required in future systems as usage increases. For example, in the United States, bandwidth efficiencies of 0.769 bits/Hz (that is, a multiplier of 1.3) are required now for terrestrial Land Mobile systems

application of these systems, Automated Meter Reading, can be scheduled for transmission during off-peak hours, further reducing the peak-to-average factor.) Any adjustment factor introduced to account for non-uniform distribution of traffic would increase the required bandwidth over the estimates made here.

- Each user can see at least one satellite every time it transmits. More satellites in sight will not reduce the bandwidth requirements, since it is assumed that the bandwidth will be shared by all satellite systems to provide service to all users. If coverage is not continuous, the required bandwidth would have to be increased, since the same number of packets would have to be transmitted in less time.
- To account for repeats of incomplete or missed transmissions, an adjustment factor of 1.35 is used.
- To account for shared frequency usage - that is, if the band will be shared with other services that will take up some of the capacity and that must be protected from interference - the shared band must be wider than that required to carry only the MSS traffic. An adjustment factor of 5 is used in this analysis, based on current terrestrial cellular experience. Assume that in a 4-MHz bandwidth, 8 000 existing terrestrial users are within interference range of a mobile earth station (MES). Assume further that each such existing user transmits for 6 minutes during an 8-hour period each day. The total traffic generated by these users would be:

$$\frac{(8\,000 \times 6)}{(8 \times 60)} = 100 \text{ Erlangs},$$

which corresponds to 128 trunks (channels) being utilized with a grade of service of P = 0.001.[3] Now, if the 4-MHz total bandwidth is divided into 160 channels of 25 kHz each, then 32 channels (160 - 128) would be available for use by MSS. That is one-fifth, or 20% percent, of the total number of 160 channels. This means that for an MSS allocation to be shared with existing users having the usage pattern assumed here, the allocation would need to be five times that of an exclusive allocation. Hence, a multiplication factor of 5 is used in the calculation of required bandwidth to account for sharing with existing terrestrial users[4].

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[3] The grade of service is the ratio of the number of calls that are not completed at first attempt, to the total number of attempts to establish a connection during a specific period of time, usually the Busy Hour.

[4] Recent tests made on an operational NVNG MSS satellite equipped with DCAAS revealed that within a footprint covering all of the United States and portions of Canada and Mexico, between 150 to 200 2.5 kHz interstitial channels out of a total of 800 channels in the 148 MHz band appeared to be unused by terrestrial mobile users for varying lengths of time (with a mean duration of about 20 seconds). That would indicate a multiplication factor of between 4 and 5 for shared use. In more heavily used bands the multiplication factor for shared used might be considerably higher.

Using these assumptions, the required channel capacity is calculated from the following equation:

$$\text{Channel Capacity} = \frac{(\text{Num of users}) \times (\text{Num of packets/day/user}) \times (1\ 024 \text{ bits/packet})}{\text{Total Transmission Time}} \text{ Bits/Second}$$

Where:

Total Transmission Time = (24 Hours/Day) x (60 Minutes/Hour) x (60 Seconds/Minute) = 86400 Seconds/Day

Table 3-1 shows the required channel capacity for each service category based on the projected number of users for all regions. There may be other projections based on different assumptions that would increase the required channel capacity. In this regard, the following is a conservative estimate.

TABLE 3-1

Channel capacity requirements

		North America		Europe		Latin America		Asia		Africa	
	Packets/ Day User	Users (kb/s)	Channel capacity	Users (kb/s)	Channel capacity	Users (kb/s)	Channel capacity	Users (kb/s)	Channel capacity	Users (kb/s)	Channel capacity
utomated Mtr. Reading	1	14,874,000	176.28	4,830,000	57.24	1,888,000	22.38	8,703,000	103.47	239,000	2.83
Remote Tracking	48	844,000	480.14	296,000	168.40	77,000	43.80	N/A	N/A	N/A	N/A
Vehicle Messaging	4	1,403,000	66.51	645,000	30.58	172,000	8.15	166,000	7.87	17,000	0.81
Personal Messaging	32	1,630,000	618.19	2,569,000	974.32	966,000	366.36	3,368,000	1277.35	103,000	39.03
SCADA	N/A	N/A		N/A		N/A		N/A		N/A	
Total			1341.12		1230.54		440.69		1388.69		42.67

N/A = not available at this time.

The largest capacity total for each region determines the channel capacity requirement. Although Asia has the highest estimate for channel capacity, the entire region cannot be covered by one footprint. In order to calculate the required bandwidth for Little LEO systems, it is necessary to consider a region that has the required channel capacity and at the same time is covered by one footprint. Since the required channel capacity for North America is comparable to that of Asia, and North America is covered by one footprint, the required channel capacity for North America has been used to calculate the required bandwidth for Little LEO systems. Thus assuming GMSK modulation and a multiplication factor of 1.35 to account for incomplete or missed transmissions, the total required uplink bandwidth is:

$$\text{Bandwidth}_{\text{exclusive}} = 1341.12 \times 1.5 \times 1.35 \text{ » } 2.72 \text{ MHz}$$

This bandwidth must be increased by the factor of 5 if it is shared with other services:

$$\text{Bandwidth}_{\text{shared}} = 2.72 \times 5 = 13.6 \text{ MHz.}$$

Therefore, 13.6 MHz of bandwidth is the minimum required for uplinks on a shared basis.[5]

3.2 Required bandwidth for NGSO MSS service downlinks

To estimate the total required bandwidth for NGSO MSS downlinks below 1 GHz, the following assumptions are made:

- The data received for Vehicle Messaging and Personal Messaging will be transmitted via service downlink.
- Automated Meter Reading and Remote Asset Tracking do not require service downlinks.
- Each user can see at least one satellite every time it transmits or receives. More satellites in sight will not reduce the bandwidth requirements, since the bandwidth will be shared by all satellite systems.
- The allocated frequency band will be used on a shared basis, using coordination and Exclusion Zone methods.
- The modulation is GMSK, which results in a channel bandwidth 1.5 times the baud rate[2] .
- To account for repeats of incomplete or missed transmissions, an adjustment factor of 1.35 is used.
- To account for shared frequency use, a multiplication factor of 5 is used. (See discussion in Section 3.1.)
- Downlink channel capacity needed for polling or frequency assignment to frequency-agile terminals is negligible compared to the channel capacity needed for uplink transmissions. (Downlink polling and frequency assignment will need a maximum of only 12 bytes per terminal, compared with a minimum uplink data length of 128 bytes for subscriber-generated information.)

Using these assumptions, the required channel capacity and bandwidth for service downlinks based on the projected number of users would be as follows:

$$\text{Channel Capacity} = 618.19 + 66.51 = 684.7 \text{ kb/s}$$

Therefore, the total bandwidth required for service downlinks on an exclusive basis is

$$\text{Bandwidth}_{\text{exclusive}} = 684.7 \times 1.5 \times 1.35 = 1.4 \text{ MHz}$$

And the shared bandwidth requirement is

$$\text{Bandwidth}_{\text{shared}} = 1.4 \times 5 = 7 \text{ MHz.}$$

This calculation is made for North America; Asia may require twice as much bandwidth, since the projected demand for messaging in Asia is twice that for North America.

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[5] The additional bandwidth for uplinks will be this total minus the spectrum now available for NGSO MSS uplinks.

3.3 Required bandwidth for NGSO MSS feeder-links

To estimate the total required bandwidth for NGSO MSS feeder links above 1 GHz, the following assumptions are made:

- The data received from Automated Meter Reading at the satellite will be sent to the ground station via the feeder downlink.
- The data received from Remote Asset Tracking at the satellite will be sent to the ground station via the feeder downlink.
- The data for Vehicle Messaging and Personal Messaging may have to utilize either feeder uplink or feeder downlink. In order to calculate the required channel capacity, both cases are considered.
- Each user can see at least one satellite every time it transmits or receives. More satellites in sight will not reduce the bandwidth requirements, since it is assumed that the bandwidth will be shared by all satellite systems to provide service to all users.
- The allocated frequency band will be used on a shared basis through the use of local coordination and exclusion zone methods. Therefore, no sharing factor need be used in the calculation of the required bandwidth for feeder links.
- Coordination and geographic separation of Earth stations can make the entire allocated bandwidth available to each satellite system.
- The modulation is GMSK, which results in a channel bandwidth 1.5 times the baud rate. The rapid roll-off of GMSK signals outside the occupied bandwidth facilitates sharing among satellite systems and with fixed services. This is particularly important for frequency bands near those allocated to the Radio Astronomy Service, which can only tolerate extremely low interference (-255 dBW/m^2/Hz).
- To account for repeats of incomplete or missed transmissions, an adjustment factor of 1.35 is used.
- Channel capacity needed for Telecommand, Telemetry and Control (TT&C) will be negligible compared to the channel capacity needed for transmission of subscriber-generated information.

Using these assumptions, the required channel capacity and bandwidth for feeder links based on the projected number of users would be:

Feeder Uplink:

Channel Capacity = 618.19 + 66.51 = 684.7 kb/s,

Required Bandwidth = 684.7 x 1.5 x 1.35 = 1.4 MHz

Feeder Downlink:

Channel Capacity = 176.28 + 480.14 + 66.51 + 618.19 = 1341.12 kb/s

Required Bandwidth = 1341.12 x 1.35 x 1.5 = 2.7 MHz

Therefore, the total bandwidth required for feeder links is 1.4 + 2.7 = 4.1 MHz.

4 Conclusion

Based on market studies of the demand for NGSO MSS services, and reasonable assumptions for calculating the spectrum required to transmit that traffic, a minimum of 20.6 MHz of bandwidth shared with other services will be required for service links in both directions of transmission, and 4.1 MHz for feeder links in both directions, as shown in Table 4-1. To determine the additional spectrum required, the existing primary allocation of approximately 3.5 MHz must be subtracted from the total required spectrum of 24.7 MHz. This leaves an additional requirement of about 21 MHz.

TABLE 4-1

Bandwidth required for NGSO MSS service and feeder links

	Bandwidth Required (MHz) **If Exclusive**	**Bandwidth Required (MHz)** **If Shared***
Service Uplinks	2.72	13.6
Service Downlinks	1.4	7.0
Service Link Total:	**4.12**	**20.6**
Feeder Uplinks		1.4
Feeder Downlinks		2.7
Feeder Link Total:		**4.1**
*NOTE - The bandwidth of allocations must be wider than the shared bandwidths shown in this column, as discussed in Section 3, above.		

TABLE 2

Required bandwidth

	Bandwidth Required (MHz) , **If Exclusive**	**Bandwidth Required (MHz),** **If Shared ***
Service Uplinks	2.72	13.6
Service Downlinks	1.4	7.0
Service Link Total:	**4.12**	**20.6**
Feeder Uplinks		1.4
Feeder Downlinks		2.7
Feeder Link Total:		**4.1**
*NOTE - The bandwidth of allocations must be wider than the shared bandwidths shown in this column because of the differences in domestic allocations, and the extent of their use in different parts of the world.		

The MSS allocation requirements include both service and feeder links (which usually operate within the service bands). In general, the inbound and outbound allocations should be approximately balanced for CDMA systems. A wider uplink allocation, however, leads to a more benign sharing situation; the wideband MSS system can operate with a lower power density by spreading over wider bandwidths. One system, with FDMA uplinks and TDMA downlinks requires approximately five times the downlink bandwidth as uplink bandwidth. Narrow band MSS systems with dynamic channel selection will occupy any given subchannel less often and will require a greater bandwidth to achieve a given message rate. Thus, the uplink and downlink allocations do not necessarily have to be equal. Note that the current studies show that on a worldwide basis an average of 3.2 million non-GSO MSS users would be provided service in each 1 MHz of bandwidth for uplinks and 6.1 million users per MHz for downlinks, when the data rates and frequency of use among the various users are taken into account.

In view of the requirements just noted, there is unlikely to be sufficient spectrum available beginning in the year 2000 to accommodate the requirements of the MSS Below 1 GHz service. For systems planned to be implemented around the year 2000 and later, there does not currently appear to be sufficient worldwide access in the available bands for such systems to grow and achieve commercial viability. Given the time required to develop and construct satellite systems, an additional 21 MHz (24.7 MHz minus the existing 3.5 MHz) on a worldwide basis is required in the immediate future if the requirements for the non-GSO MSS below 1 GHz are to be met.

ATTACHMENT B

LITTLE LEO SHARING STUDY

INTERNATIONAL TELECOMMUNICATION UNION

RADIOCOMMUNICATION STUDY GROUPS

Document 8D/TEMP/115(Rev.1)-E
5 November 1996
Original: English only

Source: Documents 8D/74, 98, 113, 132, 133, 143 and 189

Sub-Working Group 8D-3A

DRAFT TEXT FOR CPM REPORT

4.1.1.1.5 MSS (space to Earth) Sharing with the Broadcasting Service

A - Television Near 216 MHz and 800 MHz

The protection requirements specified in the Table A and Table B have been derived from published information about the needs of the broadcasting service and narrow band MSS signals (See Recommendation ITU-R BT.655-3 for protection ratios for analogue television, Recommendation ITU-R BT.417-4 for minimum field strengths to be protected and Recommendation ITU-R IS.851-1 for interservice sharing between the broadcasting and mobile radio services). Broadcasting systems which are currently using frequencies near 216 MHz, or 800 MHz, and an example of a digital system expected to be in use the relatively near future, have been included. Table A pertains to interference from a narrow band MSS signal assuming continuous interference (Grade 4 impairment), and Table B assumes tropospheric interference (Occasional Grade 3 impairment).

Although it is to be expected that digital sound and digital television services will be deployed in a number of countries(in this frequency range)over the next few years, it is also to be expected that the analogue television service will continue in many countries for many years. This is probably especially true for those countries which are relatively under-developed, where the man-made noise levels are low and where the protection requirements are most stringent simply because the noise and existing interference levels are low.

The values of maximum tolerable interfering power flux density derived in Table A are comparable to those derived elsewhere. The differences are primarily the result of different assumed bandwidths and receiver noise figures. These values are only given as an indication which maximum pfd could be used if there were no other interferers to the broadcasting services.

In order to protect existing and planned broadcasting services, according to Recommendation ITU-R IS.851-1 contributions of all interfering sources have to be combined using a method specified in that Recommendation. Since the pfd values in Table A were derived without the inclusion of any protection margin the interference contributions from other sources than MSS, even those from other broadcasting stations have also to be taken into account in these calculations.

NGSO MSS systems should be able to operate at a frequency removed from the TV vision carrier. At certain frequency separations between the NGSO MSS signal and the TV vision carrier the protection ratio drops by 13 to 20 dB (See ITU-R Rec. IS.851-1). Therefore, under certain conditions NGSO MSS sharing with the broadcasting service may be possible. Further study is required.

The operation of NGSO MSS within the broadcasting bands requires in any case a co-ordination between TV transmitters and MESs. This situation, including coordination criteria, requires further study. Further, pfd values for MSS space stations will be required for the protection of the broadcasting service.

Table A

Maximum Power Flux Densities for Narrow Band NGSO MSS in Broadcasting Bands (Continuous interference, Grade 4 impairment)

Identifier	Analogue television			Digital television	Note
	216 MHz		800 MHz	216 MHz	
	high-noise area	low-noise area			1
Nominal bandwidth(MHz)				7	
Receiver noise figure (dB)				3	2
Receiver noise input (dBW)				-132.5	
Effective receiving antenna aperture (dBm^2)				-8.2	3
Receiving antenna discrimination(dB)	0	0	0	0	4
Required C/N ratio (dB)				(20)	5
Minimum power flux density (dBW/m^2)				(-104.3)	(5)
Minimum field strength (dBμV/m)	49	43	58		1
Derived power flux density (dBW/m^2)	-96.8	-102.8	-87.8		1, 6
Derived equivalent minimum field strength (dBμV/m)				(41.5)	(5), 6
Protection ratio (dB)	58	58	58	(20)	(5), 7
Maximum interfering power flux density (dBW/m^2)	-154.8	-160.8	-145.8	-124.3	1, 8, 9
Equivalent maximum interfering field strength (dBμV/m)	-9.0	-15.0	0.0	21.5	1, 6

TABLE B

Maximum Power Flux Densities for Narrow Band NGSO MSS in Broadcasting Bands (Tropospheric interference, Occasional Grade 3 impairment)

Identifier	**Analogue television**			**Note**
	216 MHz	**216 MHz**	**800 MHz**	
	high noise area	low-noise area		
Protection ratio	50	50	50	
Maximum interfering power flux density (dBW/m²)	-146.8	-152.8	-137.8	1,9
Equivalent maximum interfering field strength (dBμV/m)	-1.0	-7.0	8.0	1,6

NOTES:

1. The values given in Table 1 of ITU-R Rec. IS.851-1 for 50% time and 90% of locations are relevant for Regions 1 and 3 in areas where man-made noise levels are significant. However, in areas where man-made noise levels are low, the appropriate values for 50% time and 90% of locations are 12 dB below the 50% time and 50% of locations value; that is, 43 dBμV/m for Band III. Such a value is expected to apply in a relatively large number of developing countries, in particular and in rural areas in other countries (see, for example ITU-R Rec. BT.417-4). The frequencies identified, 216 and 800 MHz, are intended to be representative only. The value of minimum field strength given for 800 MHz is often reduced by 5 dB in countries where the television broadcasting networks are relatively sparse. In such cases, the derived power flux density and both maximum interfering signal levels must also be reduced by 5 dB.
2. 3 dB is regarded as a minimum realistic value(not necessarily achieved in current equipment) taking account of the need to maintain low intermodulation levels.
3. An Isotropic antenna is used for digital sound and television systems as these are intended for portable applications.
4. No receiving antenna discrimination can be taken for digital applications as the antenna is assume to be isotropic. Analogue applications use directional antennas, but these are very often horizontally polarised and have wide beamwidths in the vertical plane, thus there is no discrimination against interfering signals originating in a satellite.
5. The required C/N ratios and the protection ratios for digital systems are nominal values. The actual C/N and protection ratio values will be the same for a given system and thus will have no

impact on the maximum interfering signal levels. It is for this reason that some values have been placed in parentheses.

6. Conversion between power flux density (f) and equivalent field strength (E) is by means of the formula $E = f + 145.8$ where E is in dBμV/m and f is in dBW/m².

7. The protection ratio value for analogue television is for the case of, so-called, continuous interference and will apply when the MSS signals are near the vision carrier. It must be noted that different television systems in different parts of the world use a range of vision carrier frequencies and the value quoted is thus appropriate for the general case. However, it must also be noted that the term continuous is really a misuse as it is applied to the case of 50% time interference. In those cases where interference is really continuous, in other words present for 100% of the time, it is common practice, in Europe at least, to add 3 dB to the relevant protection ratio values.

8. For the digital systems, the power flux density quoted is the total interference power tolerable. If there are multiple MSS carriers in the same pass band, their interfering power levels must be added together.

9. For the analogue system, the power flux density quoted is the interference power tolerable under the assumption that the MSS signal has relatively narrow bandwidth in which the change in protection ratio is less than 2 dB. This assumption has been adopted in order to re-use a protection ratio value which already appears within ITU-R BT.655-3. It must be noted that this is the value for single entry and it is assumed that the MSS signal is near the vision carrier of the television carrier. If these are multiple narrow band or wide band MSS signals within the television pass-band, the protection requirement will be based on the power-sum of the individual interference components. Each of these components consists of the power of an MSS signal with a bandwidth to which is added the relevant protection ratio, being dependent on the frequency difference between the MSS carrier and the vision carrier frequency. The total from the power summation process must not exceed the interfering power value for the single entry case shown in the table. For example, with the assumption that 6 MHz of NTSC television bandwidth is fully filled with spread spectrum MSS carriers like CDMA in VHF band 170 to 222 MHz, considering the combination of bandwidth factor of 6 MHz and 44 dB criteria (see ITU-R TG 11-3/37-e,12 April 1996, "Chairman's Report on the First Meeting of Task Group 11/3" Annex 10-Table 13), the value of maximum tolerable interfering power flux density is -140.8 (dBW/m²) to keep the visual quality of analogue television Grade 4.

B- FM SOUND BROADCASTING AND DIGITAL SOUND BROADCASTING

WP 10B has reviewed the Broadcasting Services Protection Criteria that could be used in sharing situations between the non-GSO mobile-satellite service and the existing FM sound broadcasting service or the Digital Sound Broadcasting (DSB) service. Tables C and D show the maximum allowable interfering pfd assuming MSS as a narrow band and a broad band system. The values are the aggregate interference level. Single entry interference values should be lower. For MSS system with many satellites in operation, the values should be lower by a factor proportional to the number of satellites. These following values are still preliminary and are applicable for all elevation angles.

TABLE C

FM Sound Broadcasting Services Protection Criteria
(Assuming Interference from Narrow band NGSO MSS)[1]

Minimum Field Strength (dBμV/m)	48
Protection ratio (dB)	55
Maximum allowable interfering pfd ($dBW/m^2/4$ kHz)	-169.1

[1] In band on channel digital sound broadcasting systems are under development to operate in Band II and may require even lower maximum allowable interfering pfds.

TABLE D

Terrestrial Digital Sound Broadcasting (DSB) Services (Digital System A) Protection Criteria
(Assuming Interference from Broad band NGSO MSS)

Frequency Band	I (45 - 70 MHz)	II (88 - 108 MHz)	III (170 - 240 MHz)
Minimum Field Strength (dBμV/m)	25	31	35
Protection ratio (dB)[2]	24	24	24
Maximum allowable interfering pfd ($dBW/m^2/4$ kHz)	-171	-164	-161
Maximum allowable interfering pfd (dBW/m^2)	-145	-139	-135

[2] Assuming MSS is a broadband digital service, based on 10 dB below normal noise floor.

ATTACHMENT 1

Radiocommunications Study Groups
Geneva, Switzerland

Document US WP-11C____
February 7, 1997

United States of America

Draft contribution to Section 4.1.1.11 of the CPM Report:
Sharing between non-GSO MSS (space-to-Earth) and the television broadcasting service

1.0 Introduction

The information in this contribution supplements the section of the Report of the CPM to WRC-97 dealing with the feasibility of sharing between non-GSO MSS space-to-Earth emissions and the television broadcasting service in the VHF and UHF bands, and other auxiliary data signals that have been proposed which may come into use in the TV broadcasting bands.

2.0 Background

Sharing between downlink transmissions from a space service and terrestrial broadcasting is not a new concept. Radio Regulation S5.311 (formerly RR 693) has long permitted use of the band 620-790 MHz, which is allocated to broadcasting on a primary basis, by stations in the broadcasting-satellite service, subject to agreement between the administrations concerned, and also subject to a power flux[1] limitation of -129 dBW/m^2 at angles of arrival less than 20° without the consent of administrations of other countries.

At its November, 1996 meeting, WP 8D revisited the question of the feasibility of sharing between these two services (Doc. 8D/TEMP/115, Rev. 1), and derived values for maximum interfering power flux that would protect analogue and digital broadcasting systems near 216 MHz and 800 MHz assuming minimum field strengths

[1]Although RR S5.311 and several of the ITU-R documents discussed in this contribution refer to "power flux density" and to its acronym, "PFD, the actual metric in all such cases is "power flux," since it is the power per unit area which is being referred to, not the power per unit area within a specific or reference bandwidth. Therefore, the distinction between the metrics will be maintained throughout this contribution.